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# DIE HEATING/COOLING TEMPERATURE CONTROL DEVICE
[Kanagata kanetsu reikyaku ondo seigyo souchi]

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SPECIFICATION /39*

1. Title of the Invention

Die Heating/Cooling Temperature Control Device

2. Claims

1. A die heating/cooling temperature control device comprising multiple heat medium tanks for selectively supplying heat mediums that have been set at multiple temperatures to a molding die, temperature adjusting means for the heat mediums, pressure pumps, and shut-off valves for selectively supplying the heat mediums characterized by

independent heat medium passages being provided to multiple cavities, fine adjusting heaters and temperature sensors being provided to the inlet sides of the above heat medium passages, temperature sensors being provided to the outlet sides of the same, and flow amount control valves being provided to the inlet sides or outlet sides of the same, and also characterized by being provided with a control device that drives said fine-adjusting heaters and flow amount control valves so that the outputs of the inlet-side sensors and the outputs of the outlet-side sensors become the same between the cavities or so that the outputs of the outlet-side and inlet-side sensors become the same.

2. A die heating/cooling temperature control device of Claim 1 characterized by being provided with a control device that drives the above-mentioned fine-adjusting heaters and flow amount control valves in a manner such that the difference between the outputs of the inlet-side sensors and the difference between the outputs of the outlet-side sensors

* Numbers in the margin indicate pagination in the foreign text.

or the differences between the outputs of the outlet-side and inlet-side sensors will match a set value.

3. A die heating/cooling temperature control device of Claim 1 characterized by being provided with a control device that stores the outputs of the inlet-side sensors and outlet-side sensors during one cycle and that, by using these output values as set values, drives the above-mentioned fine-adjusting heaters and flow amount control valves in a manner such that the outputs of the inlet-side sensors and the outputs of the outlet-side sensors or the differences between the outputs of the outlet-side and inlet-side sensors will match the above-mentioned set value in the cycles thereafter.

4. A die heating/cooling temperature control device of Claim 1, 2, or 3 characterized by being provided with a control device that is for synchronizing the operations of the above shut-off valves and the operation of the molding machine.

3. Detailed Explanation of the Invention

[Field of Industrial Application]

The present invention pertains to die heating/cooling temperature control devices equipped with multiple cavities for plastic molding, specifically to die heating/cooling temperature control devices /40 suitable for accurately controlling the temperature inside the die and for reducing the temperature differences between the cavities.

[Prior Art]

In multi-cavity molding designed to increase productivity, making the die temperatures between the cavities even is an essential condition

for reducing the variation in the molded articles.

Furthermore, plastic molded articles, such as plastic lenses, are required to have a high thickness ratio between the thick part and thin part and also to have high precision and little internal strain.

For this reason, it is necessary to prevent orientation distortion from occurring in the resin filling process by keeping the die at a high temperature and by reducing the flow resistance of the molten resin.

Moreover, in the forming process, it is necessary to prevent orientation distortion from occurring by gradually cooling the die temperature and by making the cooling solidification even.

As stated in, for example, Kokai No.58-215309, a die temperature control device utilized in conventional heating and cooling comprises a high-temperature medium tank, a low-temperature medium tank, their pressure pumps, and a shut-off valve, and it controls the heating and cooling inside the die by selecting a heat medium.

Moreover, as a die structure in which the temperatures of the cavities are equalized in multi-cavity molding, there is one in which heat medium passages are connected and made into ladder-like passages as indicated in, for example, Kokai No.59-39510.

Figure 7 is a drawing for explaining a conventional die heating/cooling temperature control device. (a) is a schematic diagram in which [1] is a high-temperature tank and [2] is a low-temperature tank. The high-temperature tank [1] is provided with a heater [3] as a temperature adjusting means, a temperature sensor [4], a pressure pump [5], a supply-side shut-off valve [6], and a return-side shut-off valve [7].

The low-temperature tank [2] is provided with a cooler [8] as a temperature adjusting means, a temperature sensor [9], a pressure pump [10], a supply-side shut-off valve [11], and a return-side shut-off valve [12].

There are two cavities, [14] and [15], inside the die [13], and each has a heat medium passage, [16] or [17], provided to it.

Moreover, [29] and [30] are relief valves for making the heat medium supply pressure constant, and [31], [32], [33], and [34] are check valves for controlling the flow direction.

(b) of the same figure is a control conceptual drawing in which [26] is a control device. By controlling the heater [3] and cooler [8] based on the outputs of the temperature sensors, [4] and [9], the heat mediums inside the high-temperature tank [1] and low temperature tank [2] are controlled to be at a prescribed temperature. It also controls the shut-off valves, [6], [7], [11], and [12], and flow control valves, [24] and [25], in synchronization with the operation of the molding machine [27].

[Problem that the Invention is to Solve]

In the above conventional technique, since the temperature differences between the cavities in the heating and cooling of the die are not taken into consideration, variations in the sizes of the molded articles occur among the cavities, and the yield of the molded articles drops significantly.

In order to prevent the temperatures of the cavities from being different from one another, it is effective to measure and control the flow and temperature of the heat medium that runs through the passage provided to each cavity.

However, a device that measures the flow of a heat medium at a high temperature, such as 200ºC or higher, is very expensive, and it is impossible to measure and control the flows of many cavities.

The purpose of the present invention is to supply a die heating/cooling temperature control device for plastic molding capable of molding plastic lenses having superb optical performance in multi-cavity molding at a high efficiency and inexpensively.

[Means for Solving the Problem]

The above purpose can be achieved by controlling flow control valves, which are provided to the heat medium supply passages running from the die temperature adjuster to each cavity or provided to the return passages running from each cavity to the die temperature adjuster, and by controlling heaters provided to the supply passages by means of sensors that are provided to the inlets and outlets of the heat medium passages of the die and that measure the temperature of the heat medium.

[Operation of the Invention]

The present invention was achieved by focusing on the temperature and flow amount of the heat medium that is made to flow into each cavity of a die, specifically by focusing on the flow amount of the heat medium running through each cavity and the temperature differences between the heat mediums at the inlet side and outlet side of each cavity.

An inlet-side fine-adjusting heater of the heat medium passage of each cavity is operated in a manner such that it makes the temperatures of the injected heat mediums match by being controlled based on the output of said inlet-side temperature sensor. /41

Moreover, the flow amount control valve provided to each cavity is controlled based on the output of the outlet-side temperature sensor of the heat medium passage of each cavity and is operated in a manner such that it matches the differences between the inlet-side and outlet-side sensor outputs or the outlet-side sensor outputs.

As a result of the above operation, it becomes possible to make the temperatures and flow amounts of the heat mediums that are injected into the heat medium passages of the cavities match.

By this, the temperatures of the cavities are matched, the sizes of the molded articles can be prevented from varying among the cavities, and the yield of the molded articles can be increased.

[Working Examples]

In the following, working examples of the present invention will be explained by using figures.

Figure 1 is a drawing for explaining one working example of the die heating/cooling temperature control device of the present invention, and reference numerals that are identical to those of Fig. 7 indicate the same components.

(a) of the same figure is a schematic drawing, in which the heat medium passages, [16] and [17], are respectively provided with fine-adjusting heaters, [18] and [19], temperature sensors, [20] and [21], on the inlet side, and temperature sensors, [22] and [23], on the outlet side.

(b) of the same figure is a control conceptual drawing. [26] is a control device that controls the heat mediums inside the high-temperature

tank [1] and the low-temperature tank [2] to be at a prescribed temperature by controlling the heater [3] and the cooler [8] based on the outputs of the temperature sensors, [4] and [9]. It also controls the heaters, [18] and [19], based on the outputs of the temperature sensors, [20] and [21], controls the flow amount control valves, [24] and [25], based on the temperature sensors, [22] and [23], and controls the shut-off valves, [6], [7], [11], and [12], and flow amount control valves, [24] and [25], in synchronization with the operation of the molding machine [27].

The operation of Fig. 1 to obtain a die temperature pattern such as that indicated in Fig. 2 will be indicated below.

Figure 2 is a die temperature change pattern with respect to time and a chart explaining the operation of each shut-off valve and flow control valve, and [28] is the die temperature of, for example, a cavity [14].

The die temperature pattern is set so that heating from the temperature [$T_1$] to the temperature [$T_2$] is carried out in the time interval [a], the temperature is kept at the temperature [$T_2$] during the time interval [b], cooling from the temperature [$T_2$] to [$T_1$] is carried out in the time interval [c], and the temperature is kept at the temperature [$T_1$] during the time interval [d].

Then, the heat medium temperature inside the high-temperature tank [1] is set to be a temperature that is sufficiently high compared to [$T_2$], and the heat medium temperature inside the low-temperature tank [2] is set to be a temperature that is sufficiently low compared to [$T_1$].

During the time interval [a], the shut-off valves [6] and [7] are opened, the shut-off valves [11] and [12] are closed, and the flow amount

control valves, [24] and [25], are made to let a large amount flow through them. Thus, a large amount of the heat medium inside the high-temperature tank is allowed to flow into the heat medium passages, [16] and [17], to heat the cavities, [14] and [15].

Next, during the time interval [b], the shut-off valves, [6], [7], [11], and [12], are handled in the same way as in the time interval [a], and the flow amount control valves, [24] and [25], are made to let a small amount flow through them. Thus, the cavities, [14] and [15], are kept at the temperature [$T_2$]. Next, during the time interval [c], the shut-off valves [6] and [7] are closed, the shut-off valves [11] and [12] are opened, and the flow amount control valves, [24] and [25], are made to let a large amount flow through them. Thus, a large amount of the heat medium inside the low-temperature tank is allowed to flow into the heat medium passages, [16] and [17], to cool down the cavities, [14] and [15].

Next, the operations of the fine-adjusting heaters, [18] and [19], the flow amount control valves, [24] and [25], and the temperature sensors, [20], [21], [22], and [23], that are for reducing the temperature variation between the cavities, which is the purpose of the present invention, will be explained.

When the temperature is adjusted by means of the conventional die heating/cooling temperature control device shown in Fig. 7, a heating or cooling speed difference, [$\delta_1$] or [$\delta_1'$], and/or a die temperature difference [$\delta_2$] occurs, as indicated in Figure 3. In this case, [28] and [28'] are, for example, the temperatures of the cavities, [14] and [15]. The causes of these differences are the differences between the

temperatures and flow amounts of the heat mediums that flow into the heat medium passages, [16] and [17], of the cavities, [14] and [15].

In order to control the temperature of the injected heat medium, the structure was designed so that the temperatures of the heat mediums that flow into the heat medium passages, [16] and [17], of the cavities, [14] and [15], are measured by the temperature sensors [20] and [21], and also so that the fine-adjusting heaters, [18] and [19], are operated.

In this working example, the heat medium having the lower temperature is determined in each of the heating, retaining, and cooling processes by using, for example, the outputs of the temperature sensor [20] as a reference temperature. The output of the fine-adjusting heater [18] of the cavity of this reference temperature side, such as the [14] side, is controlled to be zero, and the output of the fine-adjusting heater [19] of the cavity of the other side, such as the [15] side, is controlled in proportion with the difference between the reference temperature and the injected heat medium temperature, which is, for example, the output of the temperature sensor [21].

The temperature differences from the reference temperature and the fine-adjusting heater outputs are indicated in Fig. 4. Furthermore, as another control method, there is a method in which the cavity that /42
will be at the reference temperature is determined, the output of this cavity's fine-adjusting heater is made to be 50% of the rated output, and the outputs of the other cavities' fine-adjusting heaters are made to be in proportion with the difference from the reference temperature as indicated inside the parentheses as numerical values in Fig. 4.

Next, in order to control the flow amounts of the heat mediums, the temperatures of the heat mediums injected into the heat medium passages, [16] and [17], of the cavities, [14] and [15], are measured by means of the temperature sensors [20] and [21], and the temperatures of the heat mediums flowing out are measured by means of the temperature sensors [22] and [23], and the flow amount control valves, [24] and [25], are controlled based on the temperature differences between the incoming and outgoing flows.

In Fig. 5, the relationship between the temperature difference and the heat medium flow amount is indicated in terms of the heat mediums at the inlets and outlets. In this case, the temperature difference was obtained based on the inlet-side heat medium, and [37] indicates a cooling period and [38] indicates a heating and retaining period.

In a heating process, the cavity, such as [14], that has a small absolute value in terms of the heat medium temperature difference is used as the reference, and the flow amount control valve [25] of the other cavity, such as [15], is finely adjusted in the direction that reduces the flow amount so that the heat medium temperature difference will be matched with that of the reference cavity.

In a retention process, the cavity, such as [14], that has a large absolute value in terms of the heat medium temperature difference is used as the reference, and the flow amount control valve [25] of the other cavity, such as [15], is finely adjusted in the direction that increases the flow amount so that the heat medium temperature difference will be matched with that of the reference cavity.

Moreover, in a cooling process, the cavity, such as [14], that has a small absolute value in terms of the heat medium temperature difference is used as the reference, and the flow amount control valve [25] of the other cavity, such as [15], is finely adjusted in the direction that reduces the flow amount so that the heat medium temperature difference will be matched with that of the reference cavity.

The flow amount is set to the large side for heating and cooling and the flow amount is set to the small side for the retention process in the above example, and the flow amount control valve is controlled at both ends of the range in this case.

However, if there is a sufficient margin in the control range for the flow amount control valves, the absolute value of the heat medium temperature difference of a certain cavity should be used as a reference, and the heat medium temperature difference of the other cavity should be controlled to match that of the reference cavity by reducing the flow amount if the absolute value of the heat medium temperature difference of the latter cavity is greater than the reference and by increasing the flow amount if it is less.

Moreover, if the temperatures of the heat mediums that are injected by the control of said fine-adjusting heaters, [18] and [19], are matched between the cavities, [14] and [15], it is permissible to use the outlet-side heat medium temperatures for the fine-adjusting of the flow amount control valves, [24] and [25], instead of the heat medium temperature differences between the inlets and the outlets.

If the temperatures of the high-temperature tank and low-temperature tank are 195ºC and 50ºC, respectively, the maximum flow amount is 2ℓ/minute, the maximum die temperature is 170ºC, and the lowest temperature is 80ºC, in the past the heating speed was $\delta_1 \cong 2$ºC/minute and the die temperature was $\delta_2 \cong 1.5$ºC. By using the die heating/cooling temperature control device of the present invention, it is possible to make them $\delta_1 \cong 0.5$ºC and $\delta_2 \cong 0.5$ºC. As a result, the conventional variation, 10µm, in the sizes of the molded articles between the cavities could be made to be less than 3µm, and the molding yield could be increased.

Figure 6 is an explanatory drawing of another working example of the die heating/cooling temperature control device of the present invention, and (a) is a schematic drawing and (b) is a control conceptual drawing. Reference numerals that are the same as those of Fig. 1 have the same functions. [35] of (a) of the same figure is a storage part, and it can store the average value of the outputs of the temperature sensors, [20] and [22], of a certain cavity, such as [14], or the average value of the outputs between the cavities for one cycle and can output it in synchronization with the cycle.

According to (a) of the same figure, in the initial stage, the fine-adjusting heaters, [18] and [19], and the flow amount control valves, [24] and [25], are controlled by means of the temperature sensors, [20], [21], [22], and [23], and the difference between the incoming temperatures and the difference between the outgoing temperatures of the cavities are controlled in order to be kept small in the same manner as in the above first working example.

Then, when the desired die temperature pattern is obtained and the temperature differences between the cavities becomes sufficiently small, a signal from the exterior is input, and the average value of the outputs of the temperature sensors, [20] and [22], of a certain cavity, such as [14], or the average value of the outputs of the cavities, in other words, the average of the outputs of the temperature sensors, [20] and [21], and the average of the outputs of the temperature sensors, [22] and [23], obtained during one cycle, is stored by the storage device [35] of (b) of the same figure.

From the next cycle, the output of the temperature sensors stored in said storage device [35] is output again in synchronization with the cycle, and by using it as the reference value for the temperature sensors, [20], [21], [22], and [23], the fine-adjusting heaters, [18] and [19], and the flow amount control valves, [24] and [25], are controlled. As a result, it becomes possible to reduce the temperature variation /43 between the cavities and to also reduce the temperature variation between the cycles. Thus, the variation in the sizes of the molded articles can be reduced, and the molding yield can be increased.

[Effects of the Invention]

As explained earlier, according to the present invention, the differences between the heating/cooling speeds and die temperatures of multiple cavities can be reduced without the need for an expensive device such as a flow meter, the stability of the sizes of the molded articles of the cavities is increased, the molding yield is increased, and a die heating/cooling temperature control device that eliminates the

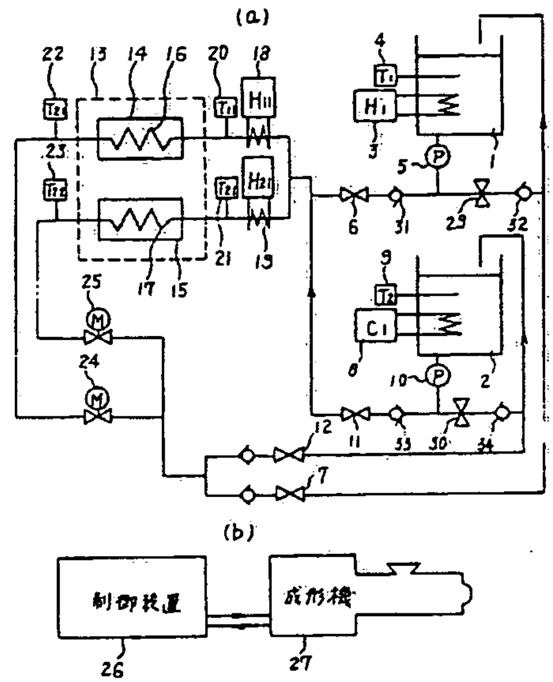
shortcomings of the above conventional technique and that has excellent features can be supplied.

4. Brief Description of the Drawings

Figure 1 is a drawing for explaining one working example of the die heating/cooling temperature control device of the present invention. Figure 2 is a die temperature change pattern with respect to time and a chart explaining the operation of each shut-off valve and flow control valve. Figure 3 is a graph for explaining the die temperature pattern. Figure 4 is a graph explaining the relationship between the temperature differences from the reference temperature and the outputs of the fine-adjusting heaters. Figure 5 is a graph explaining the relationship between the heat medium temperature difference between the inlet and outlet and the heat medium flow amount. Figure 6 is a drawing explaining another working example of the die heating/cooling temperature control device of the present invention. Figure 7 is a drawing explaining a conventional die heating/cooling temperature control device.

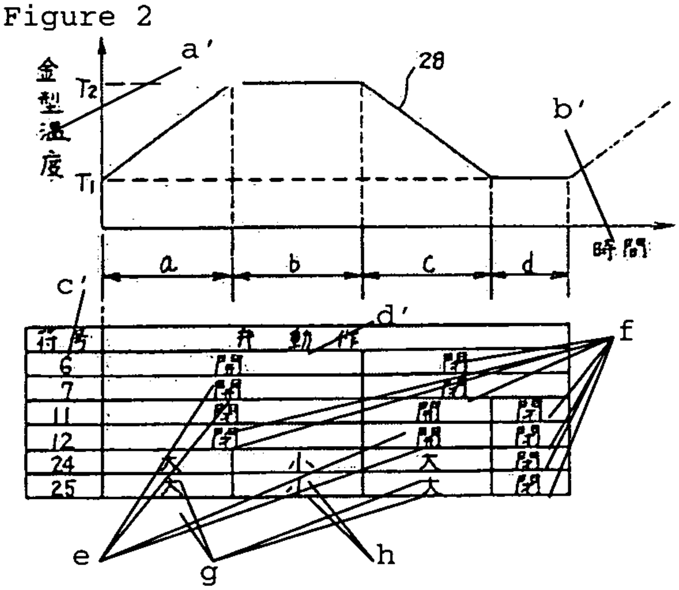
[1] = high-temperature tank
[2] = low-temperature tank
[6],[7],[11],[12] = shut-off valve
[13] = die
[14],[15] = cavity
[16],[17] = heat medium passage
[18],[19] = fine-adjusting heater
[20],[21],[22],[23] = temperature sensor
[24],[25] = flow amount control valve
[35] = storage part

[Figure 1]



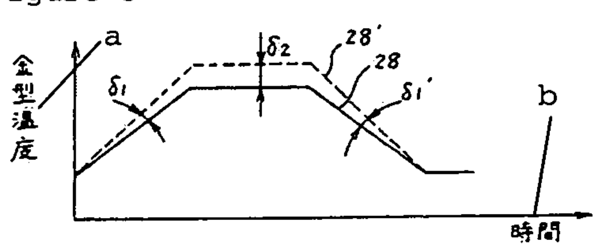

Key: 1) high-temperature tank; 2) low-temperature tank; 13) die; 14,15) cavity; 16,17) heat medium passage; 18,19) fine-adjusting heater; 20,21,22,23) temperature sensor; 24,25) flow amount control valve; 26) control device; 27) molding machine.

Figure 2



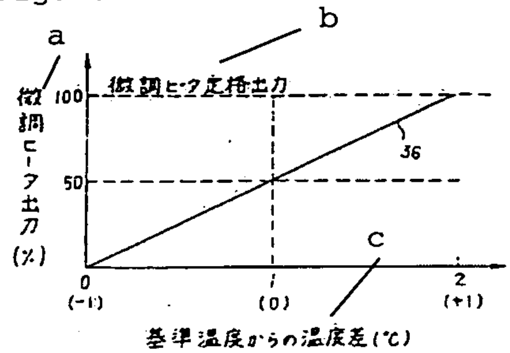

Key: a') Die Temperature; b') Time; c') Reference Numeral; d') Valve Operation; e) Open; f) Closed; g) Large; h) Small.

Figure 3



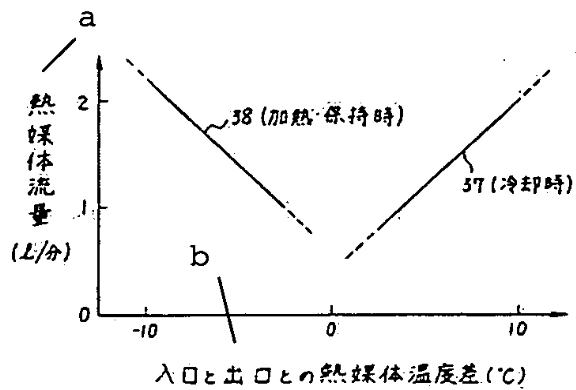

Key: a) Die Temperature; b) Time.

Figure 4 /44



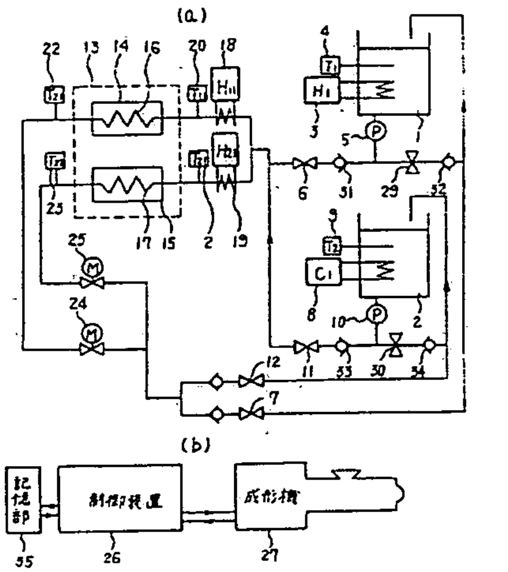

Key: a) Fine-Adjusting Heater Output (%); b) Fine-Adjusting Heater Rated Output; c) Temperature Difference from Reference Temperature (ºC).

Figure 5



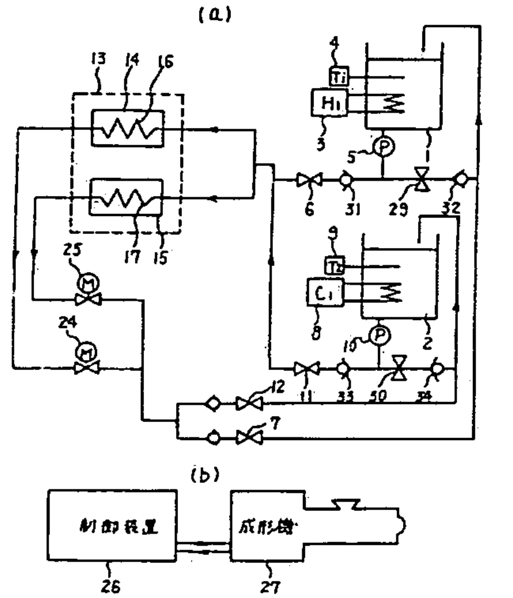

Key: a) Heat Medium Flow Amount (ℓ/minute); b) Heat Medium Temperature Difference between Inlet and Outlet (ºC); 38) (During Heating and Retaining); 37) (During Cooling).

Figure 6




Key: 35) storage part; 26) control device; 27) molding machine.

Figure 7




Key: 26) control device; 27) molding machine.

CLIPPEDIMAGE= JP402070406A

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TITLE: DIE HEATING AND COOLING TEMPERATURE CONTROL DEVICE

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INT-CL (IPC): B29C033/04

US-CL-CURRENT: **425/143**


ABSTRACT:

PURPOSE: To stabilize the dimension of a molded product and increase molding yield by controlling a **heater** installed in a feeding line of **heat mediums** from a die **temperature** controller to respective cavities and flow control valves installed in reverse return lines by means of **sensors** and measuring the **temperature of heat mediums** installed in an inlet and an **outlet of heat medium** flow channels of die.

CONSTITUTION: The temperature of heat mediums flowing into heat medium channels 16 and 17 of respective cavities 14 and 15 is sensed by temperature sensors 20 and 21 and the temperature medium flowing out is measured by temperature sensors 22 and 23 for the purpose of controlling the flow of heat mediums, and flow control valves 24 and 25 are operated and controlled by the temperature difference of inflow and outflow. In the heating process, the flow control valve 25 of the cavity 15 is microadjusted based on a cavity 14 with small absolute value of heat medium temperature difference as reference as reference in the direction in which the flow gets smaller and the heat medium temperature difference is so controlled as to conform with that of the reference cavity. In the retaining process, the flow control valve 25 of the cavity 15 is micro-adjusted based on the cavity 14 with large absolute value of heat medium temperature difference in the direction in which the flow gets larger and the heat medium temperature difference is so controlled as to conform with that of the reference cavity. Also, control is carried out in the controlling process in a manner same as the heating process.

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⑫公開特許公報（A）　平2-70406

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B 29 C 33/04　8415-4F

審査請求　未請求　請求項の数 4　（全6頁）

⑭発明の名称　金型加熱冷却温度制御装置

㉑特　願　昭63-222327
㉒出　願　昭63(1988)9月7日

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明　細　書

1. 発明の名称

金型加熱冷却温度制御装置

2. 特許請求の範囲

1. 複数の温度に設定された熱媒体を成形用金型に選択的に供給するための複数の熱媒体タンクと、熱媒体の温度調節手段と圧送ポンプと熱媒体を選択的に供給する開閉弁とからなる金型加熱冷却温度制御装置において、複数のキャビティに独立の熱媒体流路を配し、上記熱媒体流路の入口側に微調ヒータと温度センサを、出口側に温度センサを、入口側又は出口側に流量制御弁をそれぞれ設け、各キャビティ間で入口側センサの出口及び出口側センサの出力、又は出口側と入口側のセンサの出力との差が同一となるように、上記微調ヒータ及び流量制御弁を駆動する制御装置を設けたことを特徴とする金型加熱冷却温度制御装置。

2. 請求項1において、入口側センサの出力及び出口側センサの出力、又は出口側と入口側のセンサの出力との差を設定値と一致させるように上記微調ヒータ及び流量制御弁を駆動する制御装置を設けたことを特徴とする金型加熱冷却温度制御装置。

3. 請求項1において、入口側センサ及び出口側センサの1サイクルの間の出力を記憶し、この出力値を設定値として、以降のサイクルにおいて、入口側センサの出力及び出口側センサの出力、又は出口側と入口側のセンサの出力との差を上記設定値と一致させるように、上記微調ヒータ及び流量制御弁を駆動する制御装置を設けたことを特徴とする金型加熱冷却温度制御装置。

4. 請求項1，2又は3において、上記開閉弁の動作と成形機の動作を同期させるための制御装置を設けたことを特徴とする金型加熱冷却温度制御装置。

3. 発明の詳細な説明

〔産業上の利用分野〕

本発明は、プラスチック成形用の複数のキャビティを有する金型の加熱冷却温度制御装置に係り、

特に金型内の温度を精密に制御し、各キャビティ間での温度差を小さくするのに好適な金型加熱冷却温度制御装置に関する。

〔従来の技術〕

生産性の向上を目的とした多数個取りの金型成形においては、キャビティ間の金型温度を均一化することが、成形品バラツキの低減には必須の条件である。

また、プラスチック成形品、例えばプラスチックレンズは、厚肉部と薄肉部との肉厚比が大きくしかも高精度及び低内部歪が要求される。

このため、樹脂の充填工程においては、金型温度を高温に保持し、溶融樹脂の流動抵抗を低減することにより、配向歪の発生を防止する必要がある。

さらに、賦形工程においては、金型温度を徐冷し、冷却固化の均一化を図り、成形歪の発生を防止することが必要である。

従来の加熱冷却に用いる金型温度制御装置は、例えば特開昭58－215309号公報に記載されているように、高温媒体タンクと低温媒体タンクと、各々の圧送ポンプ及び上記熱媒体を選択するための開閉弁とで構成されており、熱媒体を選択することにより、金型内の加熱冷却の制御を行っている。

また、多数個取り成形において、各キャビティの温度を均一化する金型構造として、例えば特開昭59－39510号公報に記載されているように、熱媒体流路を連通して、梯子状通路としたものがある。

第7図は従来の金型加熱冷却温度制御装置の説明図であって、(a)は系統図であり、1は高温タンク、2は低温タンクで、高温タンク1には温度調節手段としてのヒータ3及び温度センサ4、圧送ポンプ5、供給側開閉弁6、帰還側開閉弁7を設け、低温タンク2には温度調節手段としての冷却器8及び温度センサ9、圧送ポンプ10、供給側開閉弁11、帰還側開閉弁12を設けてある。

金型13内には、2つのキャビティ14,15があり、各々熱媒体流路16,17が配してある。

また、29,30は熱媒体の供給圧力を一定とするためのリリーフ弁、31,32,33,34は流動方向を制御するための逆止弁である。

同図(b)は制御概念図であって、26は制御装置であり、温度センサ4,9の出力によりヒータ3、冷却器8を制御することで、高温タンク1及び低温タンク2内の熱媒体を所定の温度に制御し、成形機27の動作と同期して開閉弁6,7,11,12及び流量制御弁24,25を制御している。

〔発明が解決しようとする課題〕

上記従来技術においては、金型の加熱冷却におけるキャビティ間での温度差の点については配慮されておらず、キャビティ間の成形品寸法バラツキを生じ、成形品歩留りが大幅に低下した。

上記キャビティ間の温度差を防止するためにはキャビティ毎に配設された通路を流れる熱媒体の流量と温度を測定制御することが有効である。

しかし、高温、例えば200℃以上の熱媒体の流量を測定する装置は非常に高価であり、多くのキャビティの流量を測定制御することができない。

本発明は、光学性能の優れたプラスチックレンズを多数個取りにより、高能率、安価で成形できるプラスチック成形用の金型加熱冷却温度制御装置を提供することを目的とする。

〔課題を解決するための手段〕

上記目的は、金型温度調節機から各キャビティへの熱媒体の供給路又は各キャビティから金型温度調節機への帰還路に設けた流量制御弁及び供給路に設けたヒータを、金型の熱媒体流路の入口及び出口に設けた熱媒体の温度を測定するセンサにより制御することにより達成される。

〔作用〕

本発明は、金型の各キャビティに流入する熱媒体の温度と流量に着眼したものであり、特に各キャビティを流れる熱媒体の流量と各キャビティの入口と出口側とにおける熱媒体の温度差に着眼したものである。

各キャビティの熱媒体流路の入口側の微調ヒータは、上記入口側の温度センサの出力で制御され流入する熱媒体の温度を一致させるように駆動さ

れる。

また、各キャビティ毎に設けた流量制御弁は、各キャビティの熱媒体流路の出口側の温度センサの出力で制御され、入口側と出口側とのセンサの出力の差又は出口側のセンサの出力を一致させるように駆動される。

以上の結果、各キャビティの熱媒体流路に流入する熱媒体の温度と流量を一致させることができる。

それにより、各キャビティの温度が一致し、キャビティ間の成形品寸法のバラツキを防止し、成形品歩留りの向上を図ることができる。

〔実施例〕

以下、本発明の実施例を図面を用いて説明する。

第1図は本発明による金型加熱冷却温度制御装置の一実施例の説明図であって、第7図と同じ符号は同じものを示す。

同図(a)は系統図であり、各々の熱媒体流路16,17には、入口側に微調ヒータ18,19、温度センサ20,21、出口側に温度センサ22,23を設けてある。

同図(b)は制御概念図であって、26は制御装置であり、温度センサ4,9の出力によりヒータ3、冷却器8を制御することで、高温タンク1及び低温タンク2内の熱媒体を所定の温度に制御し、温度センサ20,21の出力によりヒータ18,19を制御し温度センサ22,23の出力により流量制御弁24,25を制御し、成形機27の動作と同期して開閉弁6,7,11,12及び流量制御弁24,25を制御している。

ここで、第2図に示したような金型温度パターンを得るための第1図の動作を以下に示す。

第2図は時間に対する金型温度変化パターンと各開閉弁及び流量制御弁の動作の説明図であって、28は例えばキャビティ14の金型温度である。

金型温度パターンは時間間隔 $a$ の間、温度 $T_1$ から $T_2$ まで加熱し、時間間隔 $b$ の間、温度 $T_2$ に保持し、次に時間間隔 $c$ の間、温度 $T_2$ から $T_1$ まで冷却し、時間間隔 $d$ の間、温度 $T_1$ に保持する設定となっている。

そこで、高温タンク1内の熱媒体温度を $T_2$ と比較して充分高い温度に、低温タンク2内の熱媒体温度を $T_1$ と比較して充分低い温度に制御装置26により設定制御する。

ここで、時間間隔 $a$ の間は、開閉弁6,7を開、開閉弁11,12を閉、流量制御弁24,25を大流量とし、高温タンク内の熱媒体を大量に熱媒体流路16,17に流し、キャビティ14,15を加熱する。

次に、時間間隔 $b$ の間は、開閉弁6,7,11,12は時間間隔 $a$ と同様とし、流量制御弁24,25を小流量とすることにより、キャビティ14,15を温度 $T_2$ に保持する。次に、時間間隔 $c$ の間は、開閉弁6,7を閉、開閉弁11,12開、流量制御弁24,25を大流量とし、低温タンク2内の熱媒体を大量に熱媒体流路16,17に流し、キャビティ14,15を冷却する。

次に、本発明の目的であるキャビティ間の温度バラツキ低減のための微調ヒータ18,19、流量制御弁24,25、温度センサ20,21,22,23の動作を説明する。

ここで、第7図に示したような従来の金型熱冷却温度制御装置により温調を行った場合には、第3図に示すような加熱又は冷却速度の差 $\delta_1$ 又は $\delta_1'$ や金型温度の差 $\delta_2$ が発生する。ここで、28,28′は例えばキャビティ14,15の温度である。これらの差が発生する原因は、キャビティ14,15の熱媒体流路16,17に流入する熱媒体の温度と流量の差である。

ここで、流入する熱媒体の温度を制御するため各キャビティ14,15の熱媒体流路16,17に流入する熱媒体の温度を温度センサ20,21で測定し、微調ヒータ18,19を駆動制御する構造とした。

本実施例では、加熱、保持、冷却の各工程において、流入熱媒体温度の低い方を、例えば温度センサ20の出力を基準温度として決め、この基準温度側のキャビティ、例えば14側の微調ヒータ18の出力を零、他のキャビティ、例えば15側の微調ヒータ19の出力を基準温度からの流入熱媒体温度、例えば温度センサ21の出力の差に比例させて制御した。

この基準温度からの温度差と微調ヒータ出力を第4図に示す。なお、他の制御方法として、第4

図にカッコ内数値として示したように、基準温度となるキャビティを一定とし、このキャビティの微調ヒータの出力を定格出力の50%とし、他のキャビティの微調ヒータの出力をこの基準温度からの差に比例させる方法がある。

次に、熱媒体の流量を制御するために各キャビティ14,15の熱媒体流路16,17に流入する熱媒体の温度を温度センサ20,21、流出する熱媒体の温度を温度センサ22,23で測定し、流入と流出とでの温度差により流量制御弁24,25を駆動制御する構造とした。

ここで、第5図に入口と出口との熱媒体の温度差と熱媒体流量の関係を示す。温度差は入口側熱媒体を基準とした場合で、37は冷却器、38は加熱及び保持時である。

そこで、加熱工程においては、熱媒体温度差の絶対値の小さなキャビティ、例えば14を基準とし他のキャビティ、例えば15の流量制御弁25を流量の小さくなる方向に微調し、熱媒体温度差を基準キャビティと一致するように制御する。

保持工程においては、熱媒体温度差の絶対値の大きなキャビティ、例えば14を基準とし、他のキャビティ、例えば15の流量制御弁25を流量の大きくなる方向に微調し、熱媒体温度を基準キャビティと一致するように制御する。

また、冷却工程においては、熱媒体温度差の絶対値の小さなキャビティ、例えば14を基準とし、他のキャビティ、例えば15の流量制御弁25を流量の小さくなる方向に微調し、熱媒体温度差を基準キャビティと一致するように制御する。

以上の例では、加熱及び冷却においては流量大側、保持工程では流量小側であり、流量制御弁の制御範囲の両端で行った場合である。

しかし、流量制御弁の制御範囲に充分余裕がある場合には、あるキャビティの熱媒体温度差の絶対値を基準とし、他のキャビティの熱媒体温度差の絶対値が基準より大きい場合には流量を小さく小さい場合には流量を大きくし、熱媒体温度差を基準キャビティと一致するように制御すればよい。

なお、前記微調ヒータ18,19の制御により流入する熱媒体の温度が各キャビティ14,15間で一致していれば、流量制御弁24,25を微調するために、入口出口の熱媒体温度差の代わりに出口側熱媒体温度を用いてもよい。

本実施例において、高温タンク及び低温タンクの温度を各々195℃,50℃、各キャビティでの最大流量2ℓ/分、金型最高温度170℃、最低温度80℃としたとき、従来は加熱速度$\theta_1$≒2℃/分、金型温度$\theta_2$≒1.5℃発生していたものを、本発明による金型加熱冷却温度制御装置を用いることにより、$\theta_1$≒0.5℃、$\theta_2$≒0.5℃とすることができた。その結果、従来のキャビティ間成形品寸法バラツキ10μmを3μm以下とすることができ、成形歩留りの向上を図ることができた。

第6図は本発明による金型加熱冷却温度制御装置の他の実施例の説明図であって、(a)は系統図、(b)は制御概念図であり、第1図と同じ符号は同じ機能を有し、同図(a)の35は記憶部であり、ある特定のキャビティ、例えば14の温度センサ20,22の出力、又はキャビティ間での出力の平均値を1サイクル間記憶し、かつこれをサイクルと同期して出力できる構造となっている。

同図(a)において、初期においては、前記第1の実施例と同様に、温度センサ20,21,22,23により微調ヒータ18,19及び流量制御弁24,25を制御し各キャビティ間での流入温度の差及び流出温度の差を小さくするよう制御を行う。

そこで、所望の金型温度パターンが得られ、かつキャビティ間の温度差が充分小さくなったときに、外部からの信号を入力し、1サイクル間の特定のキャビティ、例えば14の温度センサ20,22の出力、又はキャビティ間の出力の平均値、即ち温度センサ20,21の出力の平均と温度センサ22,23の出力の平均を同図(b)の記憶装置35により記憶する。

次回からのサイクルは、前記記憶装置35に記憶した温度センサの出力をサイクルと同期して再度出力し、これを温度センサ20,21,22,23の基準値として、微調ヒータ18,19及び流量制御弁24,25を駆動制御する。その結果、キャビティ間の温度

のバラツキを小さくし、かつサイクル間の温度のバラツキを小さくすることができ、成形品寸法バラツキを小さくし、成形歩留りを向上することができる。

〔発明の効果〕

以上説明したように、本発明によれば、多数のキャビティ間の加熱冷却速度及び金型温度の差を高価な流量計等の装置を必要とせず、小さくすることができ、各キャビティの成形品寸法の安定性が増し、成形歩留りの向上が図られ、上記従来技術の欠点を除いて優れた機能の金型加熱冷却温度制御装置を提供することができる。

4. 図面の簡単な説明

第1図は本発明による金型加熱冷却温度制御装置の一実施例の説明図、第2図は時間に対する金型温度変化パターンと各開閉弁及び流量制御弁の動作の説明図、第3図は金型温度パターンの説明図、第4図は基準温度からの温度差と微調ヒータ出力の関係の説明図、第5図は入口と出口の熱媒体温度差と熱媒体流量の関係の説明図、第6図は本発明による金型加熱冷却温度制御装置の他の実施例の説明図、第7図は従来の金型加熱冷却温度制御装置の説明図である。

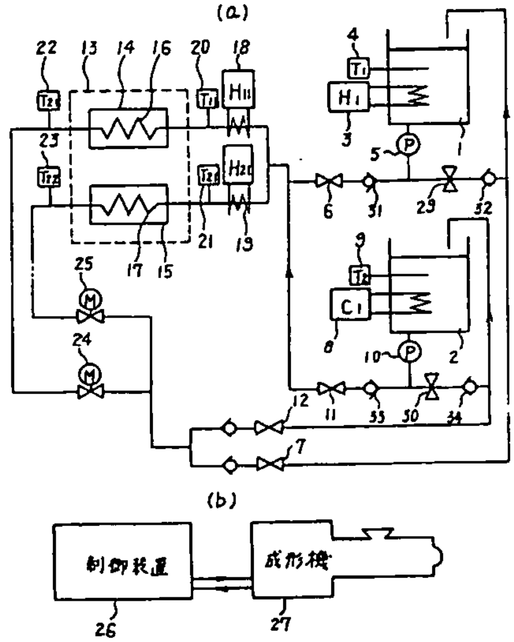
1 ………………… 高温タンク
2 ………………… 低温タンク
6,7,11,12 …… 開閉弁
13 ………………… 金型
14,15 ………… キャビティ
16,17 ………… 熱媒体流路
18,19 ………… 微調ヒータ
20,21,22,23 … 温度センサ
24,25 ………… 流量制御弁
35 ………………… 記憶部

代理人 弁理士 小 川 勝 男

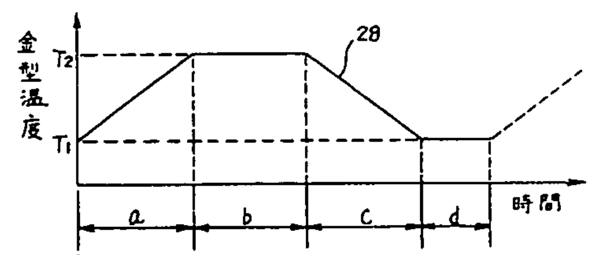
1. 高温タンク　14.15. キャビティ　20.21. 温度センサ
2. 低温タンク　16.17. 熱媒体流路　22.23. 〃
13. 金型　18.19. 微調ヒータ　24.25. 流量制御弁

第1図

(a)

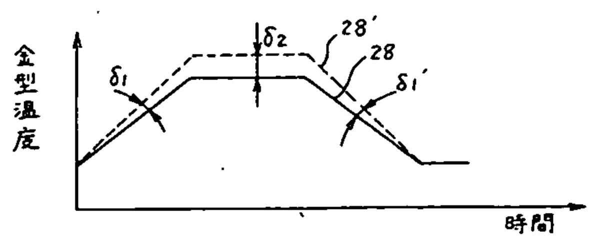



第2図

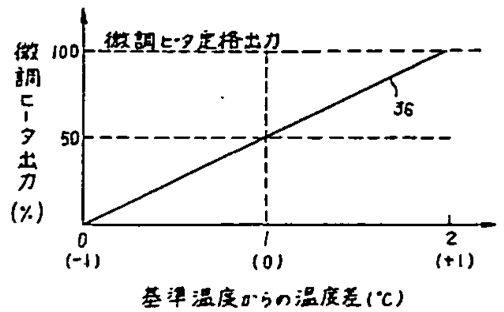



| 符号 | 弁動作 | | | |
|---|---|---|---|---|
| 6 | 開 | | 閉 | |
| 7 | 開 | | 閉 | |
| 11 | 閉 | | 開 | 閉 |
| 12 | 閉 | | 開 | 閉 |
| 24 | 大 | 小 | 大 | 閉 |
| 25 | 大 | 小 | 大 | 閉 |

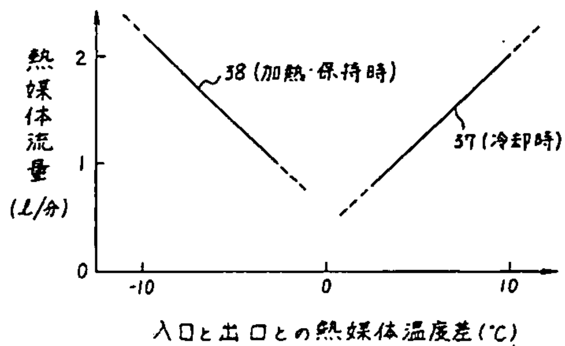
第3図



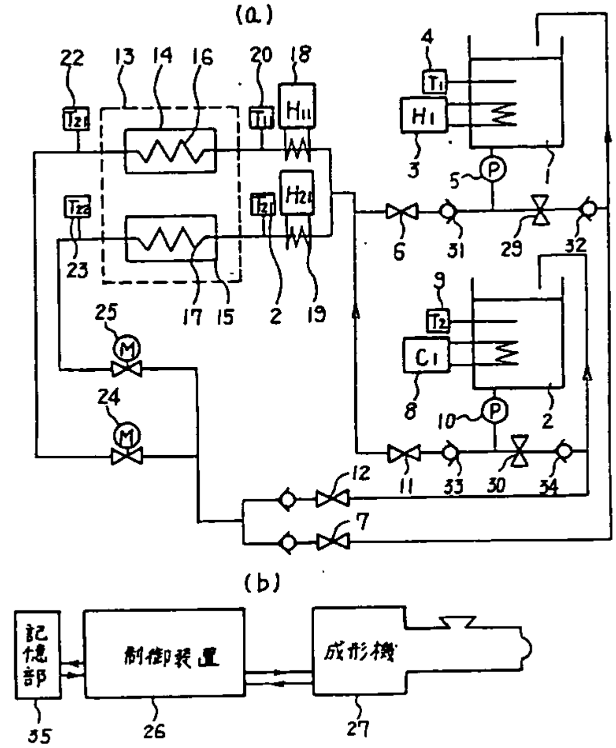
第4図




第5図




第6図




第7図